



New Biology Standards

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High School Biology: Preamble

Chemistry of Living Things, Cell Biology, Genetics, Biological Evaluation, Plant Biology, The Mammalian Body, and Ecosystems remain the fundamental principles of this rearticulation with the strands condensed to Cell Biology and Bio-Chemistry, Genetics and Evolution, Multicellular Organisms: Plants and Animals, and Ecosystems. The standards are organized to create a construct of what is being taught and assessed as a content domain specific course in Biology.

Scientific progress is made by asking relevant questions and conducting careful investigations. As a basis for understanding this concept, and to address the content in this grade, students should develop their own questions and perform investigations.

In order to demonstrate mastery of these common core science principals of Scientific Investigation and Inquiry, students should:

1. Demonstrate knowledge of the elements of scientific methodology (identification of a problem, hypothesis formulation and prediction, performance of experimental tests, analysis of data, falsification, developing conclusions, reporting results) and be able to use a sequence of those elements to solve a problem or test a hypothesis. Also, understand the limitations of any single scientific method (sequence of elements) in solving problems.
2. Know that scientists cannot always control all conditions to obtain evidence, and when they are unable to do so for ethical or practical reasons, they try to observe as wide a range of natural occurrences as possible so as to be able to discern patterns.
3. Be able to recognize the cumulative nature of scientific evidence and recognize the use and limitations of models and theories as scientific representations of reality.
4. Be able to distinguish between a conjecture (guess), a hypothesis, and a theory as these terms are used in science.
5. Have the opportunity to plan and conduct scientific investigations to explore new phenomena, to check on previous results, to verify or falsify the prediction of a theory, and to use a crucial experiment to discriminate between competing theories.
6. Be able to use hypotheses to choose what data to pay attention to and what additional data to seek, and to guide the interpretation of the data.
7. Be able to identify and communicate the sources of error (random and systematic) inherent in an experiment and be able to identify discrepant results and possible sources of error or uncontrolled conditions.

8. Be able to select and use appropriate tools and technology to perform tests, collect data, analyze relationships, and display data. (The focus is on manual graphing, interpreting graphs, and mastery of metric measurements and units, with supplementary use of computers and electronic data gathering when appropriate.)
9. Be able to formulate and revise explanations using logic and evidence, analyze situations and solve problems that require combining concepts from more than one topic area of science within the domain being studied and apply these concepts.
10. Be able to apply mathematical relationships involving linear and quadratic equations, simple trigonometric relationships, exponential growth and decay laws, and logarithmic relationships to scientific situations within each domain as appropriate.
11. Have the opportunity to observe natural phenomena and analyze their location, sequence, or time intervals (e.g., relative ages of rocks and succession of species in an ecosystem).
12. Be able to explain that science discoveries can have both positive and negative implications, involve different decisions regarding ethics and allocation of resources (e.g., organ transplants, stem cell research, forest management, and land use).
13. Be able to recognize and deal with the implications of statistical variability in experiments, and explain the need for controls in experiments.

Biology Standards

STRAND 1	Cell Biology and Bio-Chemistry
Standard 1 Bio- Chemistry	Students should appreciate that Living things are made of atoms bonded together to form molecules, some of the most important of which are large and contain carbon (i.e., “organic” compounds). In order to demonstrate this appreciation students should be able to:
	<p>B.1.1 Describe basic atomic structure using simplified Bohr diagrams to understand the basis of chemical bonding in covalent and ionic bonds.</p> <p>B.1.2. Describe the structure and unique properties of water and its importance to living things.</p> <p>B.1.3. Describe the central role of carbon in the chemistry of living things because of its ability to combine in many ways with itself and other elements.</p> <p>B.1.4. Know that living things are made of molecules largely consisting of carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur.</p> <p>B.1. 5. Know that living things have many different kinds of molecules, including small ones such as water; midsize ones such as sugars, amino acids, and nucleotides; and large ones such as starches, proteins, and DNA.</p>
Standard 2 Cells	Students should know that all living things are composed of cells. In order to demonstrate this knowledge students should be able to:
	<p>B.2.1. Describe that all organisms begin their life cycles as a single cell, and in multicellular organisms the products of mitosis of the original zygote form the embryonic body.</p> <p>B.2.2. Compare and contrast the general anatomy and constituents of prokaryotic and eukaryotic cells and their distinguishing features: Prokaryotic cells do not have a nucleus, and eukaryotic cells do. Know that prokaryotic organisms are classified in the Eubacteria and Archaeobacteria Kingdoms and that organisms in the other four kingdoms have eukaryotic cells.</p> <p>B.2.3. Demonstrate and explain that cell membranes act as highly selective permeable barriers to penetration of substances by diffusion or active transport.</p> <p>B.2.4. Explain that some structures in the eukaryotic cell, such as mitochondria, and in plants, such as chloroplasts, have apparently evolved by endosymbiosis (one organism living inside another, to the advantage of both) with early prokaryotes.</p> <p>B.2.5. Describe that all growth and development of organisms is a consequence of an increase in cell number, size, and/or products.</p> <p>B.2.6. Explain why communication and/or interaction are required between cells to coordinate their diverse activities.</p>
Standard 3 Reactions of Life	Students should know that all the fundamental life processes of a cell are either chemical reactions or molecular interactions. In order to demonstrate this knowledge students should be able to:
	B.3.1. Observe and explain the role of enzymatic catalysis in biochemical

	<p>processes.</p> <p>B.3. 2. Understand the function of cellular organelles and how the organelles work together in cellular activities (e.g., enzyme secretion from the pancreas).</p> <p>B.3. 3. Demonstrate that most cells function best within a narrow range of temperature and pH; extreme changes usually harm cells by modifying the structure of their macromolecules and, therefore, some of their functions.</p> <p>B.3. 4. Explain that complex interactions among the different kinds of molecules in the cell cause distinct cycles of activities, such as growth and division.</p> <p>B.3. 5. Explain how cell activity in a multicellular plant or animal can be affected by molecules from other parts of the organism.</p> <p>B.3.6. Explain the photosynthesis process: Plants make simple sugars and other molecules in their leaves, and chlorophyll found in the leaves can make the food and nutrients that the plant can use from carbon dioxide, water, nutrients, and energy from sunlight.</p> <p>B.3. 7. Recognize and describe that cellular respiration is important for the production of adenosine triphosphate (ATP), which is the basic energy source for cell metabolism.</p>
Standard 4 Biological Structure and Organization	<p>Student should have a clear understanding of the relationships between Biological Structure, Organization and how this impacts functionality. Specifically students should be able to:</p>
	<p>B.4.1. Explain the hierarchical organization of living things from least complex to most complex (subatomic, atomic, molecular, cellular, tissue, organs, organ system, organism, population, community, ecosystem, and biosphere).</p> <p>B.4.2. Observe and describe that within the cell are specialized parts for the transport of materials, energy capture and release, waste disposal, and motion of the whole cell or of its parts.</p> <p>B.4.3. Describe the organelles that plant and animal cells have in common (e.g., ribosomes, golgi bodies, endoplasmic reticulum) and some that differ (e.g., only plant cells have chloroplasts and cell walls).</p> <p>B.4.4. Describe that the work of the cell is carried out by structures made up of many different types of large (macro) molecules that it assembles, such as proteins, carbohydrates, lipids, and nucleic acids.</p> <p>B.4.5. Explain that a complex network of proteins provides organization and shape to cells.</p>
Standard 5 Chemical Change	<p>Students should understand how Chemical Change impacts life. Specifically students should be able to:</p>
	<p>B.5.1. Explain how layers of energy-rich organic material, mostly of plant origin, have been gradually turned into great coal beds and oil pools by</p>

	the pressure of the overlying Earth and its internal heat.
STRAND 2	Genetics and Evolution
Standard 6 Theories of Inheritance	Students should be refining their understanding of Theories of Inheritance. Specifically students should be able to:
	<p>B.6.1. Research and explain the genetic basis for Gregor Mendel’s laws of segregation and independent assortment</p> <p>B.6.2. Investigate and describe how a biological classification system that implies degrees of kinship between organisms or species can be deduced from the similarity of their nucleotide (DNA) or amino acids (protein) sequences. Know that such systems often match the completely independent classification systems based on anatomical similarities.</p> <p>B.6.3. Explain how the actions of genes, patterns of inheritance, and the reproduction of cells and organisms account for the continuity of life.</p> <p>B.6.4. Investigate and explain how molecular evidence reinforces and confirms the fossil, anatomical, behavioral, and embryological evidence for evolution, and provides additional detail about the sequence in which various lines of descent branched off from one another.</p> <p>B.6.5. Explain Gregor Mendel’s identification of what we now call “genes,” how they are sorted in reproduction, and how this led to an understanding of the mechanism of heredity. Understand how the integration of his concept of heredity and the concept of natural selection has led to the modern model of speciation and evolution.</p>
Standard 7 Genetics	Students should know that Genes are a set of instructions encoded in the DNA sequence of each organism [responsible for inheritance] and be able to apply this knowledge to problems of inheritance. Specifically students should be able to:
	<p>B.7.1. Describe how the discovery of the structure of DNA by James D. Watson and Francis Crick made it possible to interpret the genetic code on the basis of a nucleotide sequence. Know the important contribution of Rosalind Franklin’s data to this discovery (i.e., the careful X-ray crystallography on DNA that provided Watson and Crick the clue they needed to build the correct structure).</p> <p>B.7.2. Explain how hereditary information is passed from parents to offspring in the form of “genes,” which are long stretches of DNA consisting of sequences of nucleotides. Explain that in eukaryotes, the genes are contained in chromosomes, which are bodies made up of DNA and various proteins.</p> <p>B.7.3. Know every species has its own characteristic DNA sequence.</p> <p>B.7.4. Explain how biological evolution is also supported by the discovery that the genetic code found in DNA is the same for almost all organisms.</p> <p>B.7.5. Differentiate between the functions of mitosis and meiosis. Mitosis is a process by which a cell divides into each of two daughter cells, each of which has the same number of chromosomes as the</p>

	<p>original cell. Meiosis is a process of cell division in organisms that reproduce sexually, during which the nucleus divides eventually into four nuclei, each of which contains half the usual number of chromosomes.</p> <p>B.7.6. Explain how zygotes are produced in the fertilization process.</p>
Standard 8 Structure and Function of Genes	<p>Students should know that Genes specify the sequence of amino acids in proteins characteristic of that organism and how this impacts their functionality. Specifically students should be able to:</p>
	<p>B.8.1. Explain the flow of information is usually from DNA to RNA, and then to protein.</p> <p>B.8.2. Explain how the genetic information in DNA molecules provides the basic form of instructions for assembling protein molecules and that this mechanism is the same for all life forms.</p> <p>B.8.3. Understand and explain that specialization of cells is almost always due to different patterns of gene expression, rather than differences in the genes themselves.</p>
Standard 9 Biodiversity	<p>Students should understand Biodiversity as the result of genetic changes. Specifically students should be able to:</p>
	<p>B.9.1. Understand and describe how inserting, deleting, or substituting short stretches of DNA alters a gene. Recognize that changes (mutations) in the DNA sequence in or near a specific gene may (or may not) affect the sequence of amino acids in the encoded protein or the expression of the gene.</p> <p>B.9.2. Explain the mechanisms of genetic mutations and chromosomal recombinations, and when and how they are passed on to offspring.</p> <p>B.9.3. Explain how the sorting and recombination of genes in sexual reproduction result in a vast variety of potential allele combinations in the offspring of any two parents.</p> <p>B.9.4. Explain that genetic variation can occur from such processes as crossing over, jumping genes, and deletion and duplication of genes.</p>
Standard 10 Evolution	<p>Students should be cognizant of the Theory of Evolution. Specifically students should be able to:</p>
	<p>B.10.1. Describe how life on Earth is thought to have begun as one or a few simple one-celled organisms about 3.5 billion years ago, and that during the first 2 billion years, only single-cell microorganisms existed. Know that, once cells with nuclei developed about a billion years ago, increasingly complex multicellular organisms could evolve.</p> <p>B.10.2. Explain that prior to the theory first offered by Charles Darwin and Alfred Wallace, the universal belief was that all known species had been created <i>de novo</i> at about the same time and had remained unchanged.</p> <p>B.10.3. Research and explain that Darwin argued that only biologically inherited characteristics could be passed on to offspring, and that some of these characteristics would be different from the average and advantageous in surviving and reproducing; over generations,</p>

	<p>accumulation of these inherited advantages would lead to a new species.</p> <p>B.10.4. Explain that evolution builds on what already exists, so the more variety there is, the more there can be in the future.</p>
Standard 11 Environmental Impact on Evolution	<p>Students should appreciate Evolution as the result of genetic changes that occur in constantly changing environments. Specifically students should be able to:</p>
	<p>B.11.1. Explain how a large diversity of species increases the chance that at least some living things will survive in the face of large or even catastrophic changes in the environment.</p> <p>B.11.2. Research and explain how natural selection provides a mechanism for evolution and leads to organisms that are optimally suited for survival in particular environments.</p> <p>B.11.3. Explain that biological diversity, episodic speciation, and mass extinction are depicted in the fossil record, comparative anatomy, and other evidence.</p>
STRAND 3	Multicellular Organisms: Plants and Animals
Standard 12 The Plant Kingdom	<p>Students should be aware of the unique Biology of The Plant Kingdom. Specifically students should be able to:</p>
	<p>B.12. 1. Describe the structure and function of roots, leaves, flowers, and stems of plants.</p> <p>B.12.2. Know that about 250,000 species of flowering plants have been identified.</p> <p>B.12.3. Explain that during the process of photosynthesis, plants release oxygen into the air.</p> <p>B.12.4. Recognize that plants have a greater problem with “unpredictable environments” because they cannot seek shelter as many animals can.</p>
Standard 13 Plant and Animal Interactions	<p>Students should develop an understanding of Plant and animal interactions and be aware that Plants are essential to animal life on Earth. Specifically students should be able to:</p>
	<p>B.13.1. Identify the roles of plants in the ecosystem: Plants make food and oxygen, provide habitats for animals, make and preserve soil, and provide thousands of useful products for people (e.g., energy, medicines, paper, resins).</p> <p>B.13.2. Describe that plants have broad patterns of behavior that have evolved to ensure reproductive success, including co-evolution with animals that distribute a plant’s pollen and seeds.</p>
Standard 14 Mammals	<p>Students should understand how biological Systems function in the mammalian Body. Specifically students should be able to:</p>
	<p>B.14. 1. Explain the major systems of the mammalian body (digestive, respiratory, reproductive, circulatory, excretory, nervous, endocrine, integumentary, immune, skeletal, and muscular) and how they interact</p>

	with each other.
Standard 15 Homeostasis	Students should be introduced to Homeostasis using Homeostasis in the Mammalian Body. This can be understood as a result of the coordinated structures and functions of organ systems, the internal environment of the mammalian body remains relatively stable (homeostatic), despite changes in the outside environment. Specifically students should be able to:
	<p>B.15.1. Analyze the complementary activity of major body systems, such as how the respiratory and circulatory systems provide cells with oxygen and nutrients, and remove toxic waste products such as carbon dioxide.</p> <p>B.15.2. Explain how the nervous system mediates communication between different parts of the body and the environment.</p> <p>B.15.3. Describe that the nervous and endocrine systems maintain overall regulation of optimal conditions within the body by chemical communication.</p> <p>B.15.4. Investigate and cite specific examples of how the mammalian immune system is designed to protect against microscopic organisms and foreign (or nonself) substances from outside the body and against some aberrant (e.g., cancer) cells that arise within.</p>
STRAND 4	Ecosystems
Standard 16 Classification of Systems	Students should understand Classification in systems. Specifically students should be able to:
	B.16.1. Using ecological studies, explain distinct relationships and differences between urban environments and other environmental systems
Standard 17 Dynamics of Ecosystems	Students should understand Ecosystems as dynamic systems. Specifically students should be able to:
	<p>B.17. 1. Illustrate and describe the cycles of biotic and abiotic factors (matter, nutrients, energy) in an ecosystem.</p> <p>B.17. 2. Describe how factors in an ecosystem, such as the availability of energy, water, oxygen, and minerals, and the ability to recycle the residue of dead organic materials, cause fluctuations in population sizes.</p> <p>B.17. 3. Explore and explain how changes in population size have an impact on the ecological balance of a community and how to analyze the effects.</p> <p>B.17. 4. Describe how the physical or chemical environment may influence the rate, extent, and nature of the way organisms develop within ecosystems.</p>
Standard 18 Stability of Dynamic Systems	Students should understand Stability in ecosystems as a specific example of stability in Systems of dynamic equilibrium. Specifically students should be able to:
	B.18. 1. Describe how ecosystems can be reasonably stable over hundreds or thousands of years.

	B.18. 2. Explain that ecosystems tend to have cyclic fluctuations around a state of rough equilibrium, and change results from shifts in climate, natural causes, human activity, or when a new species or non-native species appears.
Standard 19 Pollution	Students should understand the effects of Pollution and other Environmental challenges and their longer term consequences. Specifically students should be able to:
	B.19.1. Investigate and describe how point and nonpoint source pollution can affect the health of a bay's watershed and wetlands. B.19.2. Assess the method for monitoring and safeguarding water quality, including local waterways such as the Anacostia and Potomac rivers, and know that macroinvertebrates can be early warning signs of decreasing water quality.